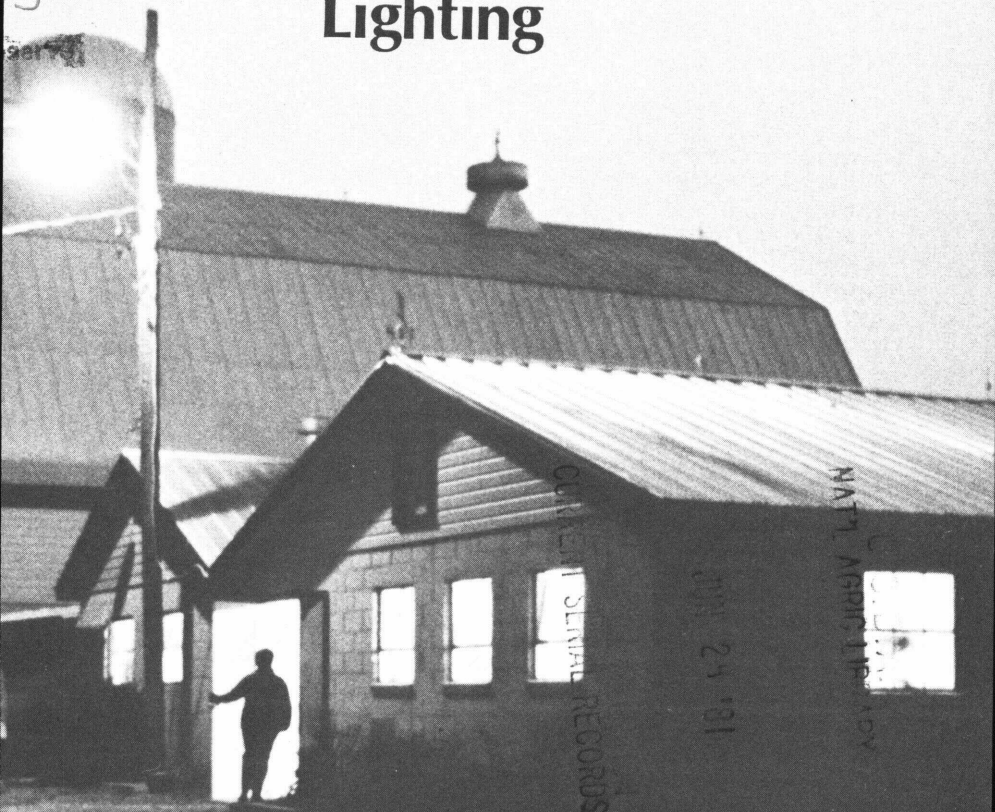


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**Farm
Lighting**



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Farm Lighting

There are many ways to get good farm lighting. This bulletin contains recommendations and suggestions for lighting farm buildings, both inside and outside.

You can also obtain help from power suppliers, State agricultural extension services, and lighting engineers and architects.

Good lighting is a combination of quantity, quality, and color of light. The quantity, measured in foot-candles, should be enough to make the object being observed clearly visible. The foot-candles recommended in this bulletin are based on established requirements for performing specific and general work by persons, except for the lighting guide for poultry production. Other levels of illumination may be desirable according to individual requirements or preferences.

Quality of lighting depends on freedom from glare, control of shadows, and the absence of sharp differences between lighted objects and the background. Glare is brightness that causes discomfort; it may be direct or reflected.

You can avoid glare from lights by proper placement of light fixtures that have diffusion louvers. To

reduce direct glare, shade the light source from view, or place the source well above the normal line of sight. Reflected glare can be reduced by using flat- or matte-finish surfaces on walls, ceilings, and work areas. Sunlight or daylight glare or brightness from windows may need shielding with blinds, louvers, or diffusers.

When the difference in brightness between objects and background is too great, the difference is annoying. A work area should be no more than five times as bright as adjacent darker surroundings, and surroundings should be no more than five times as bright as the work area.

The color of light you select should be based on a combination of esthetics, color rendition (the appearance light gives the objects it shines on), and efficiency of light sources.

Fluorescent lamps are available in a wide range of colors. Cool white, warm white, and energy-saving lamps are the most efficient. Incandescent and high-intensity discharge (HID) lamps have specific fixed colors. Table 1 shows the appearance and color rendition for various lamps.

Table 1.—Appearance and color rendering by lamp type

Type of lamp	Lamp color appears—	Color of light human skin appears—	Colors improved by lamp	Colors greyed by lamp
Fluorescent:				
Cool white (CWF)	White (bluish).	Pale pink.	Blue, yellow, orange.	Red.
Warm white (WWF)	White (yellowish).	Sallow.	Yellow, orange.	Blue, green, red.
High-intensity discharge:				
Mercury (HG)	Blue white.	Greyed.	Blue, green.	Red.
Metal halide (MH)	Greenish white.	Greyed.	Blue, green, yellow.	Red.
High-pressure sodium (HPS)	Yellowish.	Yellowish.	Green, yellow, orange.	Blue, red.
Low-pressure sodium (LPS)	Yellow.	Greyed.	Yellow.	All except yellow.
Incandescent	Yellowish white.	Ruddy.	Yellow, orange, red.	Blue.

Lighting Equipment

Incandescent lamps

Incandescent lamps are available in a wide range of sizes, types, and shapes.

Lamps up to 300 watts have standard screw bases that can be used in ordinary medium-base sockets. Nearly all incandescent lamps have a white or frosted finish that diffuses the light and reduces glare.

Most incandescent lamps used for general lighting need reflectors. These reflectors reduce glare and increase light output in the desired direction.

Some incandescent lamps have reflectors built into them to concentrate light into spotlight or floodlight patterns. Reflector lamps used outdoors should be shielded from rain, or they should be heat-resistant glass types that tolerate temperature changes without breaking.

Incandescent fixtures have a maximum wattage stamped on them. Increasing the wattage of lamps in these fixtures may cause high temperatures, fire hazards, and reduced lamp life. Porcelain sockets are recommended for incandescent lamps of more than 100 watts.

Incandescent lamps are generally selected when light is needed for short periods of time and when lamps are turned on and off frequently.

Extended service lamps have slightly reduced light output, but they last two or three times longer than standard lamps. They are useful in hard-to-reach places or other places where lamp life is preferred over efficiency.

Rough-service incandescent lamps used in portable extension cord lights are similar to standard lamps, except that they are designed to resist shock. They are identified by the words "rough service" etched on the end of the lamp opposite the base. Light output is 15 to 20 percent less than standard incandescents.

Another type of incandescent lamp is tungsten halogen. This is a gas-filled tungsten lamp with iodine or other halogens that improve operating characteristics. The light output (lumens) of standard incandescent lamps decreases about 20 percent over the life of the lamps. The light output of tungsten halogen lamps decreases only 10 percent.

Measuring Light

The total amount (or flux) of light emitted from a lamp or fixture is measured in lumens. For example, a 100-watt light bulb emits about 1,700 lumens. The amount of light on a given surface is measured in foot-candles. A foot-candle is 1 lumen uniformly distributed over 1 square foot (0.09 m²).

Fluorescent lamps

Fluorescent lamps are used mainly indoors. They are most common in cool white, warm white, white, and daylight colors. Different colored lamps of the same wattage are interchangeable in fixtures. Also, some energy-saving or low-energy fluorescents that are rated at lower wattages can replace standard lamps.

When used with low-energy ballasts, these lamps use 10 to 15 percent less power with slightly reduced light output when compared with conventional fluorescent lamps. When used with conventional ballasts, the power saving will be less. Energy-saving lamps may be a different color from the conventional cool white and warm white. Energy-saving lamps do not perform well in ambient temperatures below 60°F (16°C). This limits their use to indoor heated areas in most parts of the country.

Fluorescent lamps should be replaced when their light output falls below two-thirds of the initial output.

Fluorescent lamps require a fixture that includes a ballast which can be used with only one size (wattage) of lamp.

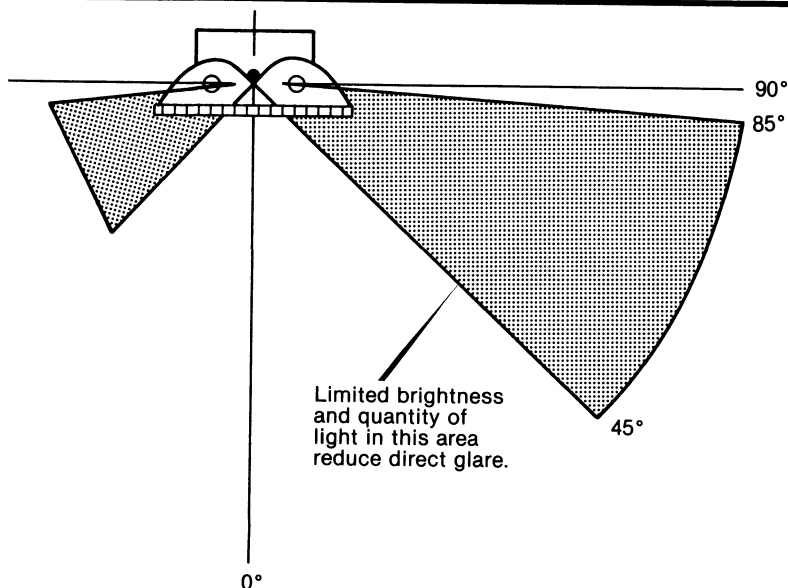


Figure 1.—Louvers in fixtures keep the angle of direct light to about 45°. Fixtures should be mounted as far as possible above the normal line of sight.

Lampholders on channel boxes that enclose the ballast and wiring are known as strip fixtures. Fixtures with a ballast and reflector are called direct or industrial fixtures.

Better brightness control and improved light output are obtained when egg-crate-type metal or plastic louvers are a part of the fluorescent fixture. These louvers keep the angle of direct light to not more than a specified angle, usually about 45° (fig. 1). Other transparent covers can be used to diffuse and control the light.

Open-louvered fixtures permit a free circulation of air. They tend to remain cleaner than enclosed fixtures, except for waterproof types. Where water from cleaning is likely to be splashed on the lamps, waterproof fixtures are recommended.

Fluorescent lamp output decreases in ambient temperatures below 60°F (16°C). For operation below 50°F (10°C), use an enclosed fixture with special ballasts. Under similar conditions, a large fluorescent (215 W) fixture requires a spe-

cial lamp with a transparent shield to maintain the lamp temperature. Below 32°F (0°C), most fluorescent lamps will not operate unless equipped with a special ballast for low temperatures.

High-Intensity discharge lamps

High-intensity discharge (HID) lamps include mercury (HG), metal-halide (MH), high-pressure sodium (HPS), and low-pressure sodium (LPS) types.

Nearly all require different individual ballasts for each wattage and type of lamp. One exception is special high-pressure sodium lamps which can operate from some mercury ballasts. Consultation with your power supplier is recommended.

High-intensity discharge lamps require 5 to 15 minutes of starting time and are not usable where lamps are turned off and on frequently. They are most useful for

general lighting indoors where ceiling or mounting height is 12 feet (4 m) or more and lamps are used 3 hours or more continuously. They are useful outdoors for security and yard lighting or other activity areas requiring night lighting. They can be controlled with a timeclock, a switch, or photoelectric cell that is activated by darkness.

High-pressure sodium lamps are the most energy-efficient where medium color rendition is acceptable. A metal halide lamp has better color rendition, but it is less efficient than a high-pressure sodium lamp. Mercury lamps can be used for replacements in existing luminaries, but new installations should use the more efficient lamps.

Low-pressure sodium lamps are used outdoors for security lighting or on feedlots where efficiency is of more concern than color rendition. Low-pressure sodium lamps make all colors look grey and will be unsatisfactory indoors.

Caution

Mercury and incandescent lamps with similar bases are not interchangeable, except for mercury lamps with built-in ballast. Both incandescent and mercury lamps are likely to be damaged or destroyed when connected to improper circuits.

Planning Good Lighting

Begin planning lighting for the farm by evaluating areas and activities where light is needed. Next, determine the foot-candle level needed for each area or activity. Table 2 gives a general guide to foot-candles needed for indoor lighting, and table 3, a guide for outdoor lighting. Then select suitable lighting equipment and have it installed properly for good light distribution.

General Indoor Lighting

Storage areas, livestock housing, machine sheds, and similar buildings need a general lighting system for safety, convenience, and efficiency (table 2). Provide supplemental light as needed for specific tools or special locations (fig. 2).

Lamp requirements for lighting most indoor work areas can be computed on the basis of fixtures mounted 7 to 10 feet above the floor. For higher mountings, the total lumens needed to light an area must be increased. The finish of the walls and ceiling should have medium to average reflectance.

Under these conditions, 2 lumens of output per lamp for each square foot (0.09 m^2) of floor area provide an average light level of about 1 foot-candle per square foot at the working level. This ratio accounts for the efficiency of the entire lighting system, including lamp output, use of reflectors, reflectance of walls, and other factors.

Normally, the lamp fixtures will be installed in rows for the length of the area. The lamps should be arranged so they provide nearly uniform lighting. When no more than 5 to 10 foot-candles of light are needed, the distance between lamps should be about 1 to $1\frac{1}{2}$ times the distance from the lamps to the floor.

When more foot-candles are needed, the spacing between lamps can be reduced to less than one times the distance to the floor so enough lamps can be used to give the required light. The distance from the outside lamps to the walls should be no more than one-half the distance between lamps.

When the spacing between lamps is $1\frac{1}{2}$ times the distance to the floor, use shallow dome reflectors. If the spacing is equal to the distance to the floor, or less, install standard-dome or deep-bowl reflectors.

The following example shows how you can determine the number of fixtures and the size of lamps that should be used in most work or storage areas:

Suppose you need 5 foot-candles of light in a machinery storage area

Table 2.—General indoor lighting guide

Area or activity ¹	Recommended foot-candles	Typical installation
	No.	
Feed storage:		
Haymow, silo, and grain bins.	3	Incandescent in protected or dustproof fixtures.
Feed inspection area and silo room.	20	Incandescent floodlight.
Concentrate storage and feed processing area.	10	Incandescent floodlight.
Livestock housing	7	Incandescent, fluorescent, or HID.
Livestock examination area	20	Incandescent spotlight or floodlight or fluorescent.
Stairways and ladders	20	Incandescent floodlight at top and bottom of stairs.
Feeding areas	20	Incandescent, fluorescent, or HID.
Machinery storage	5	Incandescent.
Machinery repair area	30	Incandescent, fluorescent, or HID.
Farm shop:		
General	30	Incandescent, fluorescent; HID if ceiling is over 12 feet high.
Bench and machine, sheet metal, and painting.	50	Incandescent floodlight or fluorescent; adjust height and group fixtures as needed.
Machine tool and detailed bench work.	100	Incandescent floodlight or fluorescent; adjust height and group lamps as needed.
Farm office	70	Incandescent or fluorescent.
Rest rooms	30	Incandescent or fluorescent.
Pump house	20	Incandescent or fluorescent.

¹See table 5 for poultry guidelines; table 6 for dairy.

Source: This table was adapted from recommendations of the Illuminating Engineering Society and American Society of Agricultural Engineers.



Table 3.—General guide for outdoor lighting

Area or activity	Recommended foot-candles	Types and ratings of lamps ¹
Security lighting	No. 0.2	High-pressure sodium, 50 to 200 watts; and low-pressure sodium, 35 to 180 watts.
General lighting for drive-ways, roads, and walk-ways.	1.0	High-pressure sodium, 100, 200, 310, or 400 watts; low-pressure sodium, 180 watts; and metal halide, 250 to 400 watts for the best color.
Activity areas, such as building entrances, live-stock lots, docks, feed-ing areas, and recreation spots.	3.0	High-pressure sodium, 200, 310, or 400 watts; metal halide, 250 to 400 watts for the best color; and low-pressure sodium, 180 watts.

¹Lamps listed here are not equal in light output (see table 4). Mounting height should be 20-25 feet, with the fixture shielded to have a 45° cutoff, as noted in the section "Fluorescent lamps." Mercury lights are omitted here because of their lower efficiency for new installations.

Source: This table was adapted from recommendations of the Illuminating Engineering Society and American Society of Agricultural Engineers.

24 feet wide and 48 feet long with the lamps installed 10 feet above the floor.

The fixtures should be 10 to 15 feet apart. If a row of fixtures is installed 6 feet from each long wall, 12 feet remain between the two rows. This provides an acceptable spacing across the 24-foot width of the area.

Next, determine the number of fixtures needed in each row. Since the area is 48 feet long and the spacing between rows is 12 feet, four fixtures per row spaced 12 feet apart will give the proper spacing. The fixtures at the ends of the rows will be

6 feet from the walls. This gives two rows of four fixtures each in the area, a total of eight fixtures.

Next, you determine the size of lamps required for each fixture. You know the floor space equals 1,152 square feet and that 2 lumens of lamp output per square foot are needed to obtain a light level of 1 foot-candle per square foot.

Multiply 1,152 by 2, and you find that 2,304 lumens are required to obtain a light level of 1 foot-candle. The work area needs a light level of 5 foot-candles. Multiply 2,304 lumens by 5 and you get 11,520 lumens, the number you need for a light level of 5 foot-candles.

To find the lamp size, divide the number of fixtures into the total lumens. This gives the lumens required per lamp. Select the correct size of lamp from table 4. When the lumens per lamp fall between lamp ratings, use the next larger size or recalculate using other lamp spacings.



Figure 2.—General workbench lighting with fluorescent fixtures provides illumination over a large area with an absence of strong shadows. Fixtures are best placed 12 inches (0.3 m) from the front edge of the bench. (BN-34621)

Table 4.—Lamp characteristics

Lamp	Rated size	Total size including ballast except for incandescents	Mean lumens	Lumens per watt, including ballast for fluorescents	Lifespan
	---Watts---		---Number---		Hours
Incandescent:					
Standard	15	15	110	7	2,500
	25	25	210	8	2,500
	40	40	410	10	1,500
	60	60	780	13	1,000
	100	100	1,580	16	750
	150	150	2,500	17	750
Extended service	40	40	380	9	2,500
	60	60	700	12	2,500
	100	100	1,340	13	2,500
	150	150	2,100	14	2,500
Fluorescent (cool white or warm white):					
Tubular, with a length, in inches, of—					
18	15	20	750	38	7,500
24	20	25	1,100	44	9,000
48 (energy-saving ¹)	34	39	2,700	69	20,000
48	40	46	2,800	60	20,000
96 (0.8 ampere)	110	126	8,000	63	12,000
96 (1.5 amperes)	215	245	12,000	49	12,000
Circular, with a diameter, in inches, of—					
6.5	20	32	600	19	12,000
8.3	22	34	760	22	12,000
12.0	32	45	1,450	32	12,000
16.0	40	54	2,060	38	12,000
High-intensity discharge (HID):					
Mercury (HG)	50	65	1,300	20	16,000
	100	120	3,600	30	16,000 +
	175	200	7,600	38	16,000 +
	250	280	11,000	39	16,000 +
	400	440	20,000	45	16,000 +
Metal halide (MH)	175	210	13,000	62	15,000
	250	290	18,500	64	15,000
	400	460	31,000	67	15,000
High-pressure sodium (HPS)	50	70	3,600	51	16,000 +
	70	90	5,220	58	16,000 +
	100	125	8,550	68	16,000 +
	150	180	14,400	80	16,000 +
	200	240	19,800	82	16,000 +
	250	295	27,000	91	16,000 +
	310	365	33,300	91	16,000 +
	400	470	45,000	96	16,000 +
Low-pressure sodium (LPS)	18	30	1,800	60	10,000
	35	55	4,800	87	18,000
	55	75	8,000	107	18,000
	90	120	13,500	112	18,000
	135	185	23,000	124	18,000
	180	230	33,000	143	18,000

+ Lamp will operate much longer but with greatly reduced output.

¹Energy-saving fluorescents provide a special color of light; they are not intended for use below 60°F (16°C).

Table 5.—Lighting guide for poultry production

Type of poultry	Age	Minimum foot-candles needed per bird
	<i>Weeks</i>	<i>No.</i>
Chickens:		
Broilers	Up to 3	1.0
Broilers	3 or more	.5
Pullets, layers, and breeders	All ages	1.0
Turkeys:		
Market stock	Up to 5	2.0
Broilers	5 or more	.5
Breeder hens and breeder toms	All ages	2.0

In this example, divide 11,520 lumens by eight lamps. This gives 1,440 lumens per lamp. From the list of lamps, you find that the required lumens for 5 foot-candles at floor level can be provided by 100-watt incandescent lamps or pairs of 15-watt fluorescent lamps or 18-watt low-pressure sodium lamps.

In areas with dark walls and a dark ceiling, or areas with no ceiling, you will need to increase the size or number of lamps.

Outdoor lighting

Outdoor lighting helps protect buildings, machinery, and livestock from prowlers. And it reduces the likelihood of accidents.

Weatherproof wiring and fixtures are used in outdoor lighting. Reflector-type incandescent lamps are used for lighting small areas and areas where lamps are used occasionally or for short periods of time. High-intensity discharge lamps and fluorescent lamps are used where light is needed for long periods of time, as they are more efficient.

Use floodlight or spotlight fixtures placed so that light will be directed to where it is needed. All outdoor lights—whether incandescent, fluorescent, or high-intensity discharge—attract insects. But yellow, orange, amber, or red lights attract few insects. Locate outdoor lamps so insects attracted by the lamps are not objectionable.

Foot-candle distribution data for floodlight and spotlight fixtures can be obtained from power suppliers and fixture manufacturers.

Poultry lighting

Light is required in poultry houses for egg and meat production and so workers can see. One or 2 foot-candles for more than half of each day are required to stimulate poultry production. Twenty foot-candles are recommended when work is being done. You may find it convenient to have two lighting systems—a low-level one for egg and meat production, and another for working and examining in the poultry house.

Table 5 gives a general guide for lighting poultry houses. For complete information on lighting to stimulate production, see "Lighting Poultry Houses," Farmers' Bulletin 2229.¹

¹For a free copy, ask your local cooperative extension service agent or write to the Office of Governmental and Public Affairs, U.S. Department of Agriculture, Washington, D.C. 20250. Send your request on a postcard, and include your ZIP code.

Dairy lighting

Incandescent and fluorescent lights are used in dairy barns, milking parlors, and milk rooms. Fluorescent lamps may be used for general lighting, and incandescent spotlights or floodlights may be used for concentrated light in specific areas. In a dairy barn, locate lamps on the ceiling, both behind and in front of the cows.

Table 6 gives a guide for lighting dairy buildings.

Light for grading

The lighting system used for grading agricultural products should provide well-diffused light of the correct color and amount. Graders must be able to see fine detail and determine the color of the products they grade. Use fluorescents with a high color-rendering index (wide spectrum).

Place the lamps 3 to 4 feet (1 m) above and 12 inches (0.3 m) in from the working side of the grading table. Use two 40-watt fluorescent lamps in industrial-type reflector fixtures placed end to end for the length of the work area.

Provide at least 50 foot-candles of light for general inspection of produce, 75 to 100 foot-candles for grading, and 150 foot-candles for extremely close inspection or grading. Lighting recommendations for grading different products may vary, depending on the authority.

Insect control lights

Many insects that fly at night are attracted to light. You can help reduce the number of nuisance insects around patios, porches, and yards by using certain fluorescent or high-intensity discharge lamps. In general, ultraviolet, blue, and green are much more attractive to insects than yellow, orange, amber, or red.

Fluorescent blacklight lamps emit radiation in the near-ultraviolet region, which is very attractive to

many insects. Farm pests attracted by these lights include European corn borers, corn earworms, tomato and tobacco hornworms, pink bollworms, and cucumber beetles.

Insect traps containing these blacklight lamps are used in insect surveys to follow migrations, detect new pests, and monitor population levels so that insecticides may be applied at the proper time.

Placement of fixtures

In the farmyard, locate lights so they do not create shadows. Direct the lights away from the vision of travelers on public roads. Light the boundaries of yards and the entrances of driveways to discourage intruders. Use automatic controls to turn the lights on and off.

In buildings, place lighting fixtures where lamps are not likely to be broken or create shadows. Keep lamps out of reach of livestock. Lamps installed in dusty places, such as haylofts and feed rooms, should be in dustproof fixtures.

A light source emits light in all directions. Reflectors help control light. The proper type of reflector will direct the light where it is needed, help reduce glare, and spread or concentrate light as desired.

For safety, direct lights downward as much as possible to avoid glare. Outdoors, recess fixtures in curbs or steps or mount them on the side of the house. Provide convenient switches for all lighting both indoors and outdoors.

Dust and dirt reduce light output. You should regularly dust the lamps, wash the fixtures, clean or repaint walls and ceilings, and replace burned out lamps or lamps which have reduced light output.

Wiring

Make certain all wiring complies with local and national electrical codes. All materials used should carry the label of Underwriters' Laboratories (UL).

Both wiring and fixtures in most farm buildings are often exposed to corrosive fumes and moisture. In

Table 6.—Lighting guide for dairy buildings and equipment

Area or activity	Recommended foot-candles needed	Typical lamp installation
	<i>No.</i>	<i>Type</i>
Feeding area	20	Incandescent or fluorescent.
Milking area	20	Incandescent or fluorescent.
Cow's udder	50	Incandescent spotlight or fluorescent in milking parlors; fluorescent in stall barns.
Milk-handling equipment:		
Milk room and general use	20	Incandescent or fluorescent.
Washing area	100	Weatherproof fluorescent fixtures, two-lamp, 40-watt, adjustable height.
Bulk tank, inside	100	Incandescent spotlights directed at tank interior, not over tank.

Source: This table was adapted from recommendations of the Illuminating Engineering Society and American Society of Agricultural Engineers.

buildings that house livestock, use approved moisture-resistant materials, such as porcelain-insulated fixtures, galvanized-steel or molded-plastic junction boxes, and branch circuit cables with a cable outer covering.

Light switches should be conveniently located on walls. Do not use pull chains; they are inconvenient, likely to break, and may be safety hazards. Switches should be installed at all entrances and exits where lighting must be controlled from more than one point.

Plan for future as well as present needs. Lighting is only one of several key considerations in determining the total load on an electrical system. Your local electric contractor or electric power supplier can give you helpful information on the wiring needs of your farm.

Your wiring should allow you to—

- Turn on lights ahead of you as you go from place to place.
- Turn walkway lights on and off from all key work areas.
- Turn on stairway lights before you start up or down the steps.
- Turn lights on and off from each entrance in rooms or areas with two or more entrances.
- Control outdoor floodlights or yard lights from the inside of all frequently used buildings.
- Operate outside lights with a timeclock or a photoelectric cell that is activated by darkness.

